PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Takuya MIYAKAWA, et al.

Appln. No.: PCT/JP01/04248

Confirmation No.: Not Yet Assigned

Group Art Unit: Not Yet Assigned

Filed: January 22, 2002

Examiner: Not Yet Assigned

For: HEAD MEMBER, METHOD FOR INK-REPELLENT TREATMENT AND APPARATUS FOR THE SAME

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Page 3, second full paragraph:

The conventional ink-repelling method by the eutectoid plating with the fluorocarbon resin and the nickel has required much time and labor as cleaning of the nozzle plate before and after the plating was required, which has been a cause of lowering productivity and increasing the labor. Moreover, in the case where the ink ejection ports have a complicated shape, spots not being subjected to the plating may exist on the ejection surfaces. When such spots not being subjected to the plating exist on the ejection surfaces 203, the attached ink remains on the spots, and the ink changes its ejection trajectory; which has been a problem. And, since the eutectoid plating includes not only the fluorocarbon resin but also the nickel, ink repellency is deteriorated

by that amount. Moreover, since it takes time to form the eutectoid plating, there has been a problem in terms of working efficiency. Still further, when the ink-repelling method using the eutectoid plating is performed, there has been a problem since a cost thereof is high.

Page 5, second full paragraph:

In the second aspect, the hydration degree of the ink-repellent film can be restrained to be relatively low.

Page 5, seventh full paragraph:

In the fourth aspect, a ratio of CF_3 contained in the ink-repellent film is relatively low, and a polymerization degree is relatively high.

Page 5, eighth full paragraph:

A fifth aspect of the present invention according to any one of the first to sixth aspects is the head member characterized in that the hydration degree of the ink-repellent film is 0.2 or lower.

Page 5, ninth full paragraph:

In the fifth aspect, by restraining the hydration degree of the ink-repellent film to be relatively low, that is, by relatively decreasing a ratio of a hydroxyl group contained in the ink-repellent film, the ink repellency is improved.

Page 24, first full paragraph:

In the ink-jet recording head 10 thus constituted, since the piezoelectric element 19 extends toward the nozzle plate 15 when a voltage is applied to the electrode forming materials

20 and 21 of the piezoelectric element 19, the elastic plate 13 is displaced, and a volume of the pressure generating chamber 12 is compressed. Hence, for example, it is possible to remove a voltage in a state where a bias voltage of about 30V is applied in advance and to make the piezoelectric element 19 shrink, thus causing the ink to flow from the reservoir 17 through the ink supply port 16 into the pressure generating chamber 12. And thereafter, by applying a voltage, the piezoelectric element 19 is extended, the pressure generating chamber 12 is shrunk by the elastic plate 13, and ink droplets are ejected from the ejection port 14.

Page 33, first full paragraph:

The case shown by a reference code C in Fig. 4 will be described. The code C denotes an ink-repellent film formed on the surface of the nozzle plate made of steel (SUS), which is obtained by the plasma polymerization of a linear perfluoro carbon C_8F_{18} in the vacuum. Formation time of this ink-repellent film C is 20 minutes, and electric power of 200 W is applied thereto. A film thickness of this ink-repellent film C is 0.1 μm. At this time, carbon tetrafluoride is not introduced thereto. As shown in Fig. 4, the ink-repellent film C thus formed had the hydration degree of about 0.025 and the relative polymerization degree of about 0.18.

Page 34, last full paragraph:

The case shown by a reference code E in Fig. 4 will be described. The code E denotes an ink-repellent film formed on the surface of the nozzle plate, which is obtained by the plasma polymerization of the linear perfluoro carbon C_8F_{18} in the vacuum. Formation time of this ink-repellent film E is 10 minutes, and electric power of 350 W is applied thereto. During the plasma polymerization, carbon tetrafluoride is introduced thereto. A material of the nozzle plate

is steel (SUS), and a film thickness of this ink-repellent film E is 0.03 μm. Moreover, as described in the embodiment, the film E is formed as an ink-repellent film in such a manner that the nozzle plate is disposed on one side of the electrode made to discharge plasma and the fluorocarbon resin are formed directly on this nozzle plate. As shown in Fig. 4, the ink-repellent film E thus formed had the hydration degree of about 0.015 and the relative polymerization degree of about 0.06.

Page 35, third full paragraph:

In the film F, both of the relative polymerization degree and the hydration degree can be greatly reduced and the performance in ink repellency can be improved when compared with those of the film B. Moreover, the values in both of the hydration degree and the relative polymerization degree can be reduced even in comparison with those of the film A, and the performance in the ink repellency can be improved more than in the case of the eutectoid plating.

Page 36, first full paragraph:

As described above, in the ink-repellent films denoted by the codes 0 to F, the hydration degree is restrained in a range of 0.2 or lower, and the relative polymerization degree is also restrained in a range of 0.2 or lower. It is understood that the ink repellency of the ink-repellent film can be improved by restraining the hydration degree and the relative polymerization degree of the ink-repellent film to be relatively low in such a manner.

IN THE CLAIMS:

The claims are amended as follows:

4.(Amended) The head member according to claim 1, wherein a relative polymerization degree of said ink-repellent film is 0.2 or lower.

5.(Amended) The head member according to claim 1, wherein a hydration degree of said ink-repellent film is 0.2 or lower.

6. (Amended) The head member according to claim 1, wherein said ink-repellent film is provided only in the vicinity of apertures of said ejection ports.

7. (Amended) The head member according to claim 1, wherein said ink-repellent film does not exist on inner surfaces of said ejection ports.

8. (Amended) The head member according to claim 1, wherein the head member is a nozzle plate formed by drilling said ejection ports in a flat plate.

9. (Amended) The head member according to claim 1, wherein said ejection ports and at least a part of pressure generating chambers communicating with said ejection ports are formed.

10. (Amended) The head member according to claim 1, wherein the head member consists of a single crystal silicon substrate.

11. (Amended) An ink-jet recording head, comprising:
the head member according to claim 1;
a passage-forming substrate defining pressure generating chambers communicating with ejection ports of the head member; and
pressure applying means for applying pressure to ink in said pressure generating chambers.

18. (Amended) The ink-repellent treatment method according to claim 13, wherein, after the deposition of said ink-repellent film, process gas is converted into plasma, and the plasma gas is flown into said ejection ports, thus removing the ink-repellent film in the ejection ports.

21. (Amended) The ink-repellent treatment method according to claim 18, wherein said process gas is flown into said ejection ports from a surface side of said nozzle plate without said ink-repellent film formed thereon.

22. (Amended) The ink-repellent treatment method according to claim 13, wherein, after the deposition of said ink-repellent film, ultraviolet rays are radiated into said ejection ports to remove the ink-repellent film in the ejection ports.

24. (Amended) The ink-repellent treatment method according claim 13, wherein, after the deposition of said ink-repellent film, electron beams are radiated into said ejection ports to remove the ink-repellent film in the ejection ports.

31. (Amended) The ink-repellent treatment apparatus according to claim 26, wherein a dew condensation prevention heater is provided on an introduction path for introducing said perfloro carbon into said chamber to enable said perfloro carbon to be heated.

32. (Amended) The ink-repellent treatment apparatus according to claim 26, wherein temperature maintaining means for maintaining said head member in said chamber at a constant temperature.

37. (Amended) The in-micropore fluorine plastic removing method according to claim 33, wherein gas is flown into said micropores by evacuating on one side of said micropores.

REMARKS

Entry and consideration of this Amendment is respectfully requested.

Respectfully submitted,

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Date: January 22, 2002

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The specification is changed as follows:

Page 3, second full paragraph:

The conventional ink-repelling method by the eutectoid plating with the fluorocarbon resin and the nickel has required much time and labor as cleaning of the nozzle plate before and after the plating was required, which has been a cause of lowering productivity and increasing the labor. Moreover, in the case where the ink ejection ports have a complicated shape, spots not being subjected to the plating may exist on the ejection surfaces. When such spots not being subjected to the plating exist on the ejection surfaces 203, the attached ink remains on the spots, and the ink changes its ejection trajectory; which has been a problem. And, since the eutectoid plating includes not only the fluorocarbon resin but also the nickel, ink repellency is deteriorated by that amount. Moreover, since it takes time to form the eutectoid plating, there has been a problem in terms of working efficiency. [Furthermore, since a layer of the fluorine plastics that is formed by the eutectoid plating has a thin film thickness, there has been a problem in terms of durability.] Still further, when the ink-repelling method using the eutectoid plating is performed, there has been a problem since a cost thereof is high.

Page 5, second full paragraph:

In the second aspect, [a relative] <u>the</u> hydration degree of the ink-repellent film can be restrained to be relatively low.

Page 5, seventh full paragraph:

In the fourth aspect, a ratio of CF_3 contained in the ink-repellent film is relatively [high] low, and [the ink repellency is improved] a polymerization degree is relatively high.

Page 5, eighth full paragraph:

A fifth aspect of the present invention according to any one of the first to sixth aspects is the head member characterized in that the [relative] hydration degree of the ink-repellent film is 0.2 or lower.

Page 5, ninth full paragraph:

In the fifth aspect, by restraining the [relative] hydration degree of the ink-repellent film to be relatively low, that is, by relatively [increasing] decreasing a ratio of a hydroxyl group contained in the ink-repellent film, the ink repellency is improved.

Page 24, first full paragraph:

In the ink-jet recording head 10 thus constituted, since the piezoelectric element 19 extends toward the nozzle plate 15 when a voltage is applied to the electrode forming materials 20 and 21 of the piezoelectric element 19, the elastic plate 13 is displaced, and a volume of the pressure generating chamber 12 is compressed. Hence, for example, it is possible to [apply] remove a voltage in a state where a bias voltage of about 30V is applied in advance [in a state where a voltage is removed in advance] and to make the piezoelectric element 19 shrink, thus causing the ink to flow from the reservoir 17 through the ink supply port 16 into the pressure generating chamber 12. And thereafter, by applying a voltage, the piezoelectric element 19 is

extended, the pressure generating chamber 12 is shrunk by the elastic plate 13, and ink droplets are ejected from the ejection port 14.

Page 33, first full paragraph:

The case shown by a reference code C in Fig. 4 will be described. The code C denotes an ink-repellent film formed on the surface of the nozzle plate made of steel (SUS), which is obtained by the plasma polymerization of a linear perfluoro carbon C_8F_{18} in the vacuum. Formation time of this ink-repellent film C is 20 minutes, and electric power of 200 W is applied thereto. A film thickness of this ink-repellent film C is 0.1 μm. At this time, carbon tetrafluoride is not introduced thereto. As shown in Fig. 4, the ink-repellent film C thus formed had the [relative] hydration degree of about 0.025 and the relative polymerization degree of about 0.18.

Page 34, last full paragraph:

The case shown by a reference code E in Fig. 4 will be described. The code E denotes an ink-repellent film formed on the surface of the nozzle plate, which is obtained by the plasma polymerization of the linear perfluoro carbon C_8F_{18} in the vacuum. Formation time of this ink-repellent film E is 10 minutes, and electric power of 350 W is applied thereto. During the plasma polymerization, carbon tetrafluoride is introduced thereto. A material of the nozzle plate is steel (SUS), and a film thickness of this ink-repellent film E is 0.03 μm. Moreover, as described in the embodiment, the film E is formed as an ink-repellent film in such a manner that the nozzle plate is disposed on one side of the electrode made to discharge plasma and the fluorocarbon resin are formed directly on this nozzle plate. As shown in Fig. [5] 4, the ink-

repellent film E thus formed had the hydration degree of about 0.015 and the relative polymerization degree of about 0.06.

Page 35, third full paragraph:

In the film F, both of the relative polymerization degree and the [relative] hydration degree can be greatly reduced and the performance in ink repellency can be improved when compared with those of the film B. Moreover, the values in both of the [relative] hydration degree and the relative polymerization degree can be reduced even in comparison with those of the film A, and the performance in the ink repellency can be improved more than in the case of the eutectoid plating.

Page 36, first full paragraph:

As described above, in the ink-repellent films denoted by the codes 0 to F, the [relative] hydration degree is restrained in a range of 0.2 or lower, and the relative polymerization degree is also restrained in a range of 0.2 or lower. It is understood that the ink repellency of the ink-repellent film can be improved by restraining the [relative] hydration degree and the relative polymerization degree of the ink-repellent film to be relatively low in such a manner.

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Page 48, "What is claimed is:" the claims are amended as follows:

4. .(Amended) The head member according to ~~any one of~~ claims 1 ~~to 3~~, wherein a relative polymerization degree of said ink-repellent film is 0.2 or lower.

5. (Amended) The head member according to ~~any one of~~ claims 1 ~~to 4~~, wherein a ~~relative~~ hydration degree of said ink-repellent film is 0.2 or lower.

6. .(Amended) The head member according to ~~any one of~~ claims 1 ~~to 5~~, wherein said ink-repellent film is provided only in the vicinity of apertures of said ejection ports.

7. .(Amended) The head member according to ~~any one of~~ claims 1 ~~to 6~~, wherein said ink-repellent film does not exist on inner surfaces of said ejection ports.

8. .(Amended) The head member according to ~~any one of~~ claims 1 ~~to 7~~, wherein the head member is a nozzle plate formed by drilling said ejection ports in a flat plate.

9. .(Amended) The head member according to ~~any one of~~ claims 1 ~~to 7~~, wherein said ejection ports and at least a part of pressure generating chambers communicating with said ejection ports are formed.

10. .(Amended) The head member according to ~~any one of~~ claims 1 ~~to 9~~, wherein the head member consists of a single crystal silicon substrate.

11. .(Amended) An ink-jet recording head, comprising:
the head member according to ~~any one of~~ claims 1 ~~to 10~~;
a passage-forming substrate defining pressure generating chambers communicating with ejection ports of the head member; and
pressure applying means for applying pressure to ink in said pressure generating chambers.

18. .(Amended) The ink-repellent treatment method according to ~~any one of~~ claims 13 ~~to 17~~, wherein, after the deposition of said ink-repellent film, process gas is converted into plasma, and the plasma gas is flown into said ejection ports, thus removing the ink-repellent film in the ejection ports.

21. .(Amended) The ink-repellent treatment method according to ~~any one of~~ claims 18 ~~to 20~~, wherein said process gas is flown into said ejection ports from a surface side of said nozzle plate without said ink-repellent film formed thereon.

22. (Amended) The ink-repellent treatment method according to ~~any one of~~ claims 13 ~~to 17~~, wherein, after the deposition of said ink-repellent film, ultraviolet rays are radiated into said ejection ports to remove the ink-repellent film in the ejection ports.

24. .(Amended) The ink-repellent treatment method according ~~to any one of~~ claims 13 ~~to 17~~, wherein, after the deposition of said ink-repellent film, electron beams are radiated into said ejection ports to remove the ink-repellent film in the ejection ports.

31. .(Amended) The ink-repellent treatment apparatus according to ~~any one of~~ claims 26 ~~to 30~~, wherein a dew condensation prevention heater is provided on an introduction path for introducing said perfloro carbon into said chamber to enable said perfloro carbon to be heated.

32. .(Amended) The ink-repellent treatment apparatus according to ~~any one of~~ claims 26 ~~to 31~~, wherein temperature maintaining means for maintaining said head member in said chamber at a constant temperature.

37. .(Amended) The in-micropore fluorine plastic removing method according to ~~any one of~~ claims 33 ~~to 36~~, wherein gas is flown into said micropores by evacuating on one side of said micropores.

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Takuya MIYAKAWA, et al.

Appln. No.: PCT/JP01/04248 Group Art Unit: Not Yet Assigned

Confirmation No.: Not Yet Assigned Examiner: Not Yet Assigned

Filed: January 22, 2002

For: HEAD MEMBER, METHOD FOR INK-REPELLENT TREATMENT AND APPARATUS FOR THE SAME

PROPOSED AMENDMENT TO DRAWINGS

Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicants request the Examiner's approval of changes to Fig. 4 as shown in red in the attached copy of original Fig. 4. The changes are consistent with the specification.

On the assumption that the proposed drawing change will be approved, the formal drawings submitted herewith incorporate the changes to Fig. 4.

Respectfully submitted,

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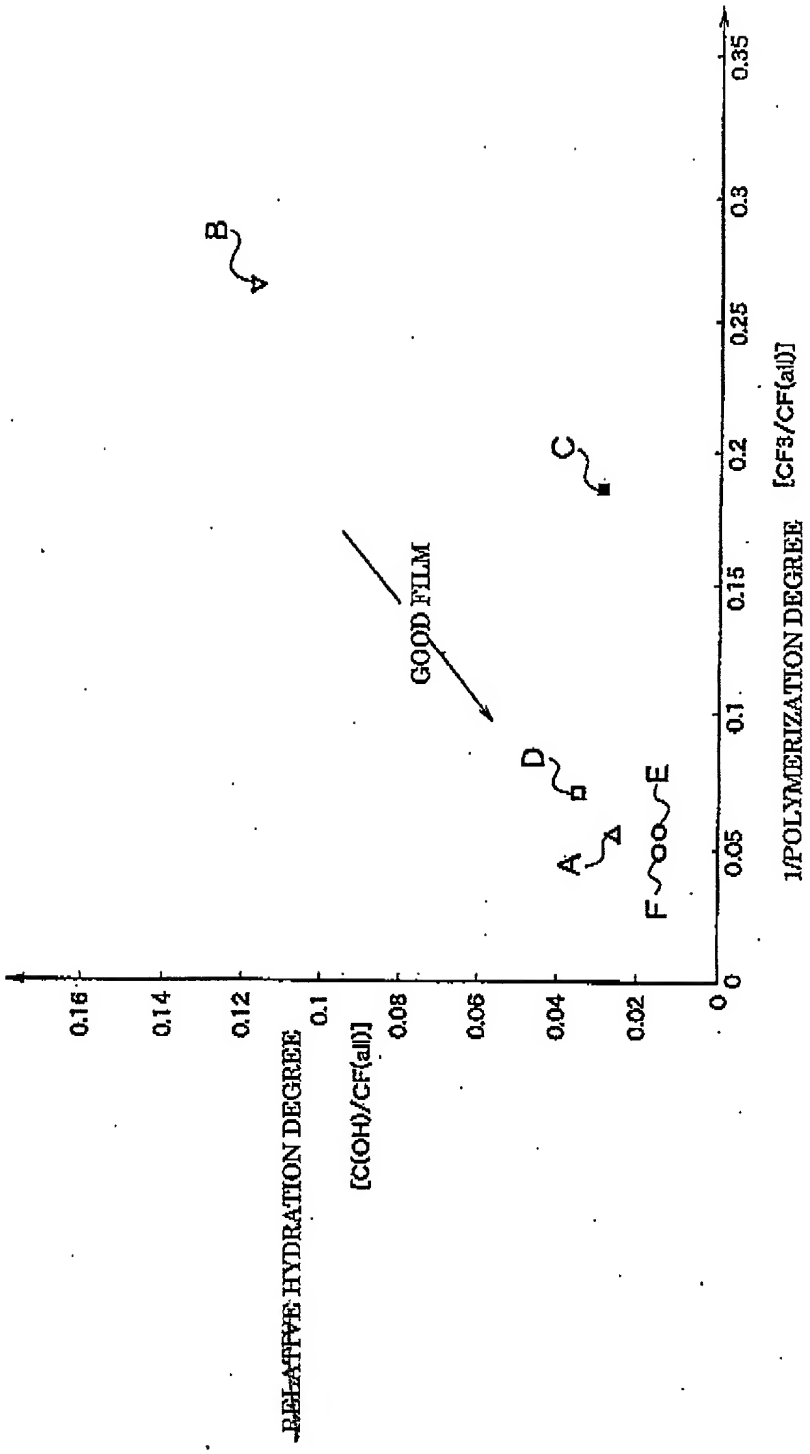
FIG. 4


RELATIVE HYDRATION DEGREE
[C(OH)/CF(all)]
1/POLYMERIZATION DEGREE [CF3/CF(all)]
GOOD FILM
A
B
C
D
E
F
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.05
0.1
0.15
0.2
0.25
0.3
0.35